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GA6HP26Z AUTOMATIC TRANSMISSION

Model: E65 - 745i / E66 - 745Li

Engine: N62B44

Production Date: 11/2001 - E65, 01/2002 - E66

Objectives of The Module

After Completing this module, you will be able to:

- List the GA6HP26Z designation.
- Describe Stand By Control.
- Name the clutches used in the GA6HP26Z.
- Identify what is unique about 5th and 6th gear.
- Explain the Parking Lock function.
- Demonstrate how to use the Emergency Release.
- List the Mechatronic components.
- Name the two paths of communication for the Selector Lever.
- Explain the L mode.

GA6HP26Z Automatic Transmission

Purpose of The System

BMW has developed a new automatic six speed gearbox together with ZF (Zahnradfabrik Friedrichshafen), designated the GA6HP26Z for the E65. It represents a further development of transmission technology and features innovations used for the first time in BMW automatic gearboxes. This gearbox makes an important contribution to the "revolutionary" features of the E65 in the luxury class segment.

G = Gearbox
A = Automatic
6 = Number of gears (speeds)
HP = Hydraulic planetary gear
26 = size
Z = Gearbox manufacturer ZF
(Zahnradfabrik Friedrichshafen)

42-05-00

GA6HP26Z Auto Transmission

The GA6HP26Z is designed in two versions for the different E65 engines. There is a more powerful version available for the V-12 that differs with the following components:

- Power output and torque characteristics
- Torque converter
- Clutches with different numbers of steel discs and lined plates
- Lepelletier planetary gear train with a different number of planet gears

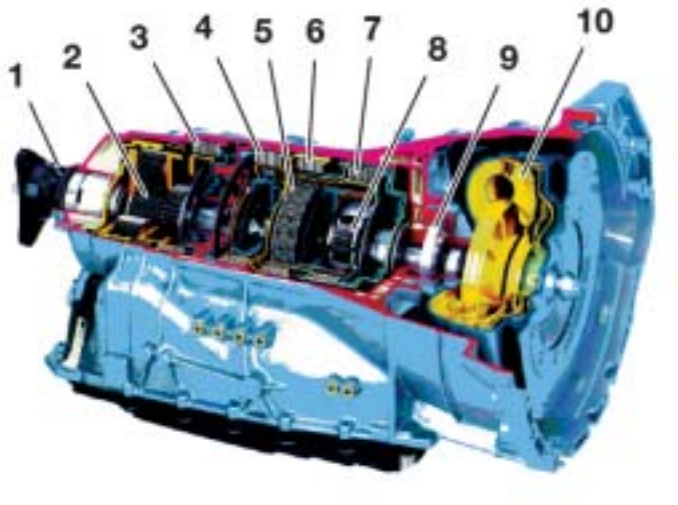
The gearbox used in the 745i is designed for a torque of 440 Nm. The more powerful version (760i) is designed for a power output of 320 kW/435 bhp and a torque of 600 Nm. The fundamental design and function of both gearbox versions are the same.

Mechanical Design of the Gearbox

The mechanical power transmission of the gearbox has been optimized with regard to gearshift comfort, quality and reduced fuel consumption. The engine torque is transferred to the gearbox by a torque converter with a controlled lockup clutch. The six forward gears and the reverse gear are produced by a Lepelletier planetary gear train. The gears are shifted by multi-disc clutches.

1. Output shaft
2. Double gear train
3. Clutch D
4. Clutch C
5. Clutch E
6. Clutch B
7. Clutch A
8. Single gear train
9. Oil pump

10 Torque converter with lockup clutch



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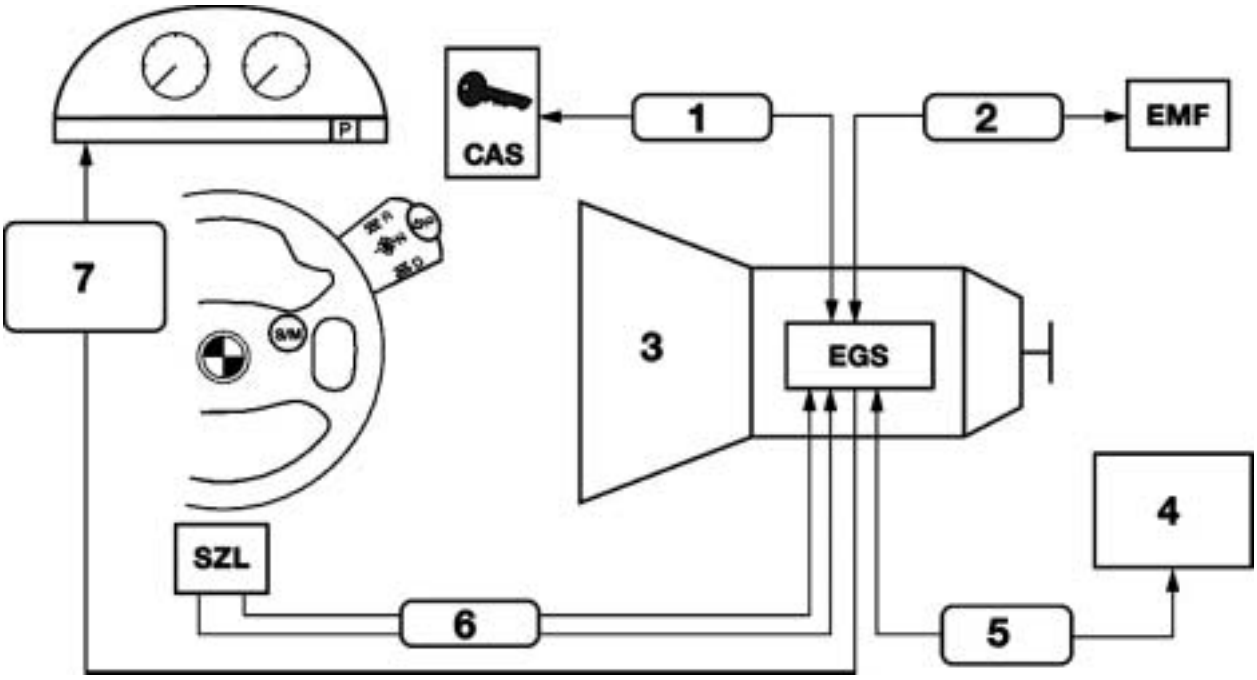
The new automatic gearbox has the following advantages:

- Designed as a 6-speed gearbox with an overdrive ratio in 5th and 6th gear, fuel consumption is reduced by up to 5 percent.
- The 6-speed gearbox allows for more gear spread, improving vehicle acceleration.
- The new 6-speed gearbox is approximately 30 kg lighter and 50 mm shorter as compared to the previously used gearbox (A5S560Z).
- The number of transmission components has been reduced from approx. 660 parts in a 5-speed gearbox to approx. 470 parts for the new 6-speed gearbox.
- The number of interfaces has been reduced by using the Mechatronics Module for the electronic transmission.

Transmission Control

The gearbox is controlled by the Mechatronic Module that is a combination of the valve body and electronic control module. The following system overview shows the main components of the electronic control system.



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Transmission Control

1. Key signal, starter interlock
2. Redundancy (park lock, n)
3. Automatic gearbox
4. Controls in vehicle interior (for emergency release)
5. Mechanical emergency release for parking lock
6. Driver's choice P,R,N,D,(L,-)
7. Shift pattern (shift gate)
   Position indicator P, R, N, D, L1...L6
   Shift lock indicator
   Error message

CAS - Car access system
EMF - Electromechanical parking brake
EGS - Electronic transmission control (in mechatronic module)
SZL - Steering column switch center

The driver's request is transmitted in the form of an electrical signal from the selector lever on the steering column or from several control buttons in the multifunction steering wheel. The signals are transferred over the CAN bus to the transmission control module. In the gearbox, the commands are implemented while evaluating various ambient conditions. The relevant positions are indicated in the instrument cluster.

Pure electronic transmission control (shift by wire) eliminates the conventional gearshift lever in the center console and all of the associated components. There are additional safety enhancements, for example the automatic parking lock is active when the ignition key is removed. In the event of faults or complete failure of electrical connections or system components, numerous measures are provided:

- An additional serial data link (hard wire) between the selector lever and Mechatronic
- The display of error messages in the instrument cluster and/or in the CC display
- The mechanical emergency park release

Technical Data: The following table lists the technical data of the gearbox versions.

Technical Data	Explanation
Gearbox Type	Passenger vehicle automatic gearbox with 6 forward gears and one reverse gear in standard arrangement
Transmission Data 745i	Max torque at 4200 rpm **440** Nm Max power output at 6600 rpm 230 KW / 313 bhp
Transmission Data 760i	Max. torque at 4200 rpm 600 Nm Max. power output at 5800 rpm 320 kW / 435 bhp
Converter	Slip-controlled torque converter lockup clutch in the gears 1 to 6 Max. permissible continous speed 7000 rpm
Transmission Ratios	1st gear 4.171 / 2nd gear 2.34/ 3rd gear 1.521 / 4th gear 1.143 / 5th gear 0.867 / 6th gear 0.697 / reverse gear 3.403
Control	Electrohydrualic with adaptive electronic control
Weight	84 to 90 kg with oil depending on version

42-05-03

Mechanical System Components

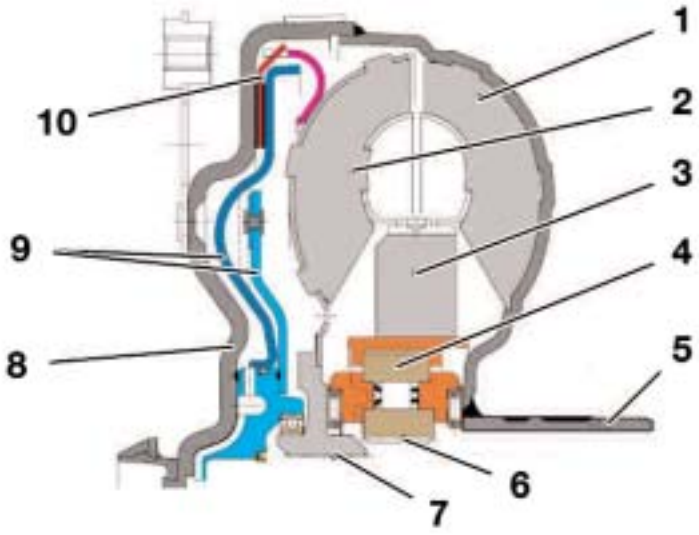
The new features/changes of the individual components as compared to previous BMW automatic transmissions will be covered. The component and functional description follows the power flow progression in the gearbox, from the torque converter to the output shaft.

Torque Converter and Lockup Clutch: The torque converter is the link for transmitting power from the engine to the gearbox. It converts high speed/low torque into low speed/high torque with a slight slip from the fluid coupling. The integral converter lockup clutch eliminates slip during the transfer of rotational speed.

The torque converter clutch is locked when the control module diverts oil pressure in the converter. The oil flow is reversed to depressurize the area in front of the clutch and apply pressure to the back side of the clutch pushing it against the converter housing. The clutch plate locks the turbine wheel directly to the converter housing allowing it to rotate as a unit without slip.

The lockup clutch is a two-friction surface clutch. It is slip-controlled in all forward gears (1 through 6). The operating points when the lockup clutch is engaged are increased which reduces fuel consumption.

1. Pump
2. Turbine
3. Stator
4. Overrunning Clutch
5. Torque Converter Hub
6. Stator Shaft
7. Turbine Shaft
8. Torque Converter Casing
9. Piston for lockup clutch
10. Lined clutch plate



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Torque Converter & Lockup Clutch

The lockup clutch will not engage until the oil temperature is >35 ºC. The control of the lockup clutch depends on various factors such as:

- Load requirement signal
- Vehicle speed
- Engine load status
- Gearbox oil temperature
- Selected gearshift program

Examples:

- Control of the lockup clutch takes place in the XE program (extreme economy) in gears 1 through 6 at a speed of approx. >30 km/h when a load requirement of <50% is present. The lockup clutch is disengaged if the load requirement is >50%.

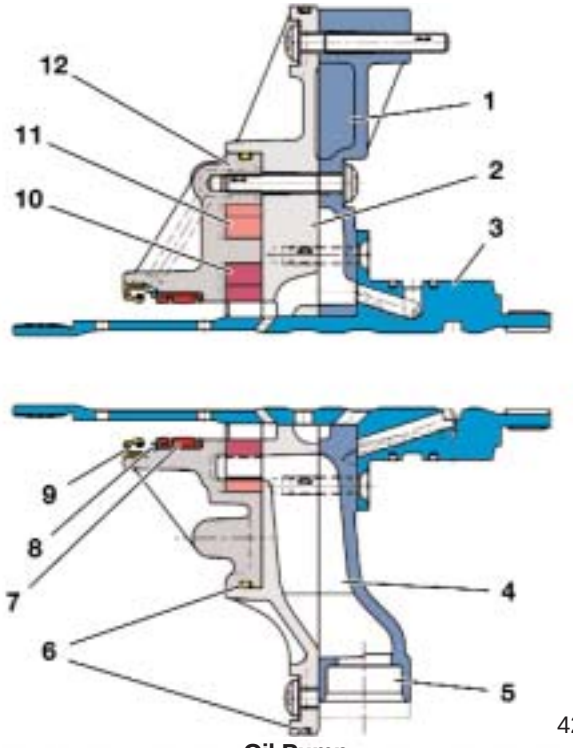
- The converter clutch is engaged from a speed of approx. 80 km/h in all forward gears. It is engaged at a speed of 20 km/h at full load or kick-down.

There are small oil channels in the lining of the lockup clutch. This oil circuit quickly reduces the temperature in the torque converter after the lock-up clutch engages.

The GA6HP26Z has a new feature of reducing the load on the engine when the vehicle is stationary and the brake pedal pressed. The turbine (input) shaft is uncoupled from the drive so that only a minimum load remains, reducing fuel consumption. The uncoupling phase is achieved by a control feature of the "A" clutch which is called ***Stand By Control (SBC).*** The pressure is reduced in the A clutch allowing the turbine shaft and torque converter to turn freely until acceleration is requested.

Oil Pump: The oil pump supplies the required oil pressure and lubricating oil for the automatic gearbox. It is a crescent-type pump and a delivery control valve is not required. The converter is supported by a needle bearing in the pump housing.

1. Intermediate Plate
2. Centering Plate
3. Stator shaft
4. Intake
5. To Oil Strainer (intake pipe)
6. O-ring
7. Bearing
8. Snap ring
9. Rotary shaft seal
10. Impeller
11. Internal Gear
12. Pump Housing



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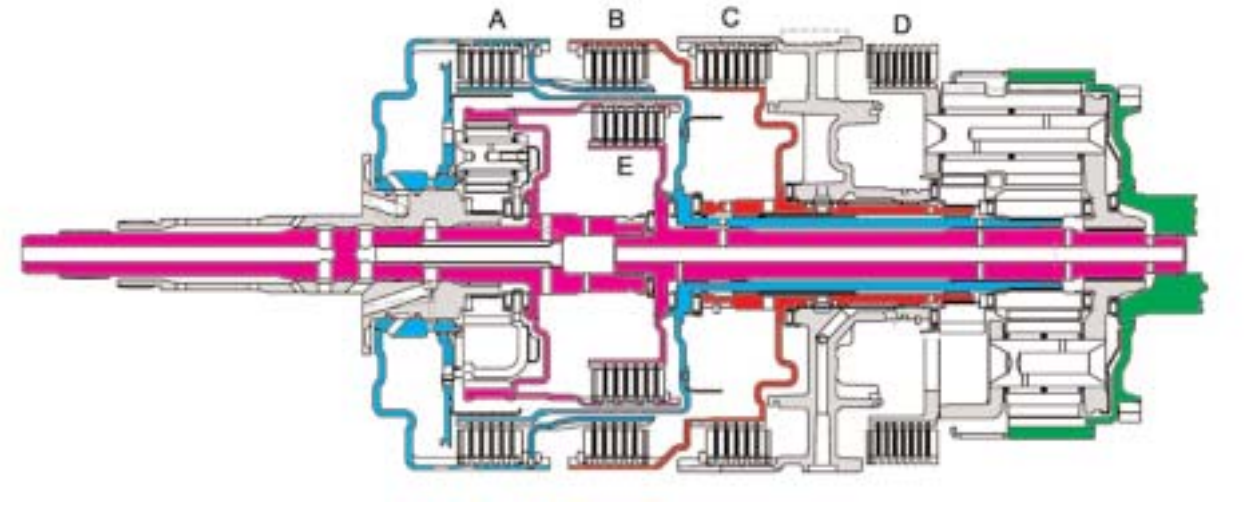
Oil Pump

Multi-disc Clutches: The GA6HP26Z gearbox requires only 5 clutches to engage 6 gears. The clutches are divided into drive clutches and brake clutches. Clutches A, B and E are drive clutches while clutches C and D are brake clutches. The A, B and E drive clutches are “dynamic pressure” balanced.



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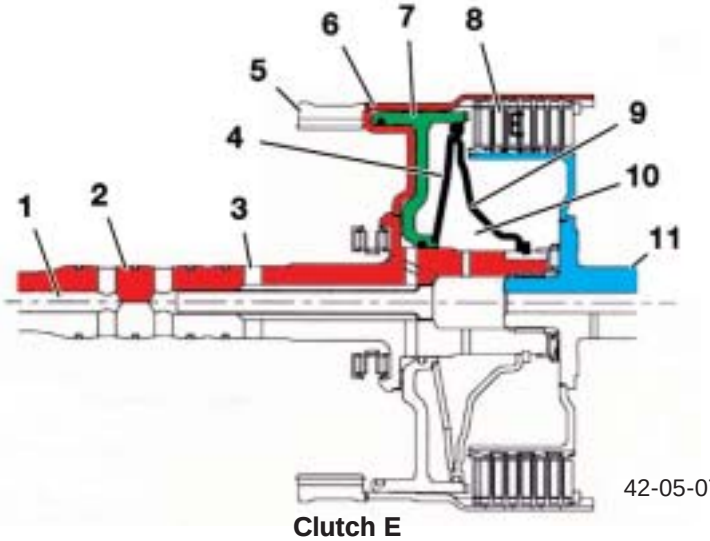
A Drive clutch **B Drive clutch** **C Brake clutch** **D Brake clutch** **E Drive clutch**

Dynamic Pressure Balance (Example: Clutch E)

Oil is applied to the clutch piston on both sides to avoid speed dependent pressure reduction in the clutch. This balance is achieved by the pressure plate (9) and the non-pressurized residual oil in the lubricating oil gallery (1) through which the area between the piston and pressure plate is filled with oil. This ensures the clutch disengages and engages exactly in all speed ranges while also improving gearshift comfort.

1. Lubrication Oil Gallery
2. Turbine shaft
3. Main pressure for clutch E
4. Disc Spring
5. Internal gear for single gear train
6. Cylinder E (outer disc carrier)
7. Piston E
8. Clutch assembly E
9. Pressure plate
10. Area for pressure compensation
11. Inner disc carrier E



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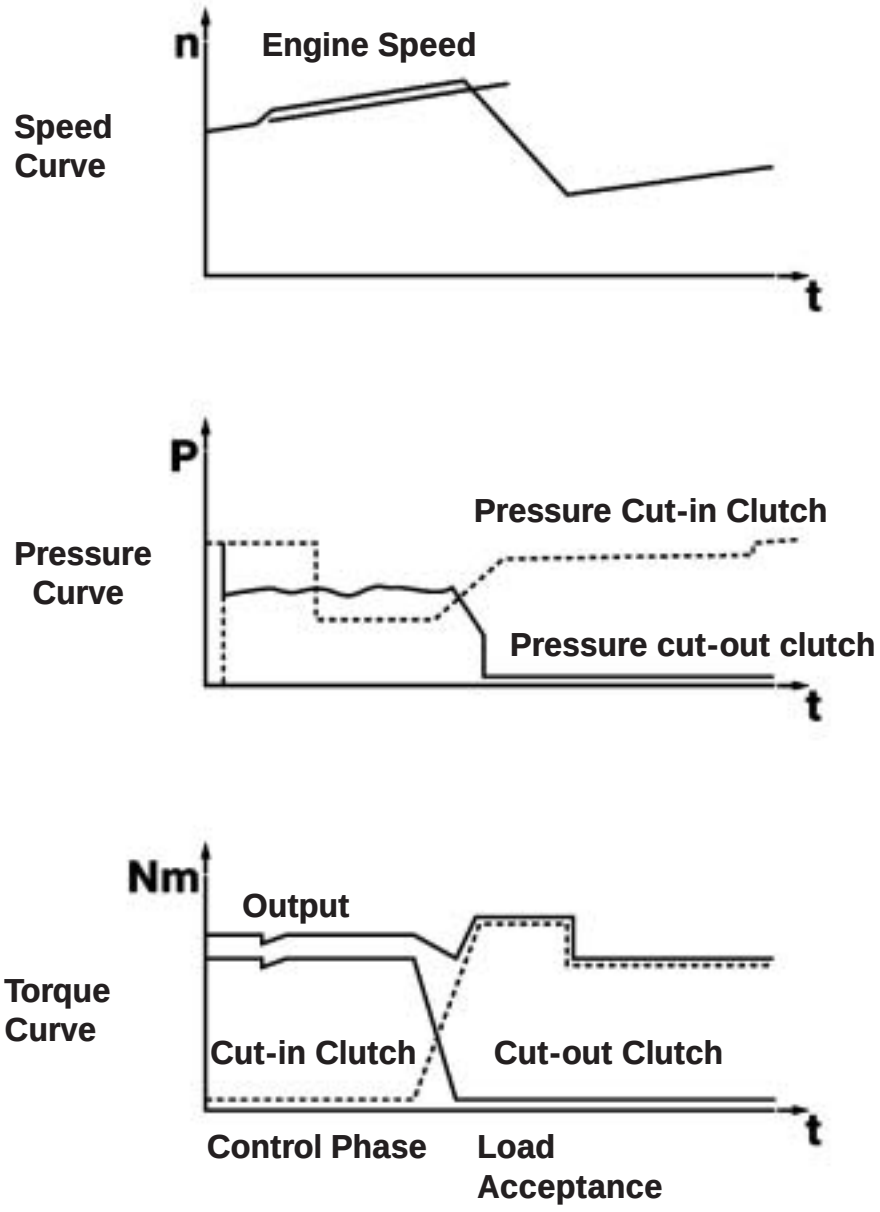
Clutch E

Free wheel gearshifts (using overrunning clutches) are not used in this transmission. In the GA6HP26Z gearbox, all gearshifts from 1st to 6th gear and from 6th to 1st gear are executed as overlap shifts. The overlap gearshift system saves weight and space. The electro-hydraulic gearshift is executed by valves in the valve body that are controlled by pressure regulators. The speed, pressure and torque curves are shown in the following diagrams.



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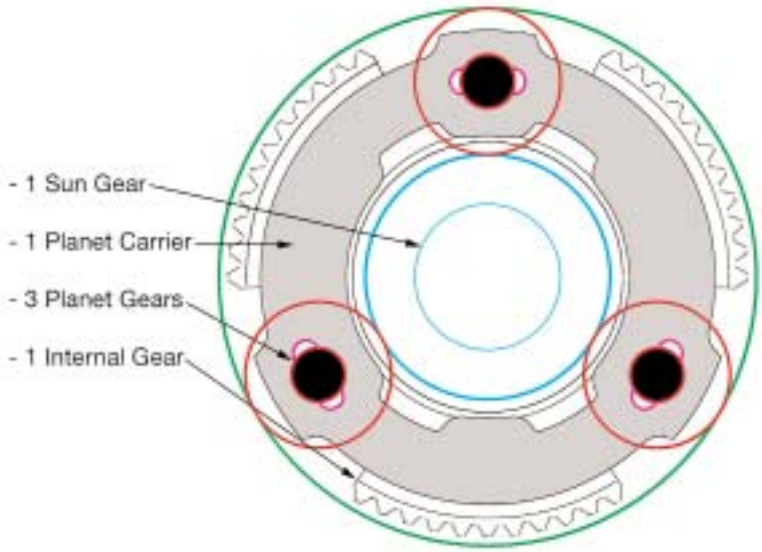
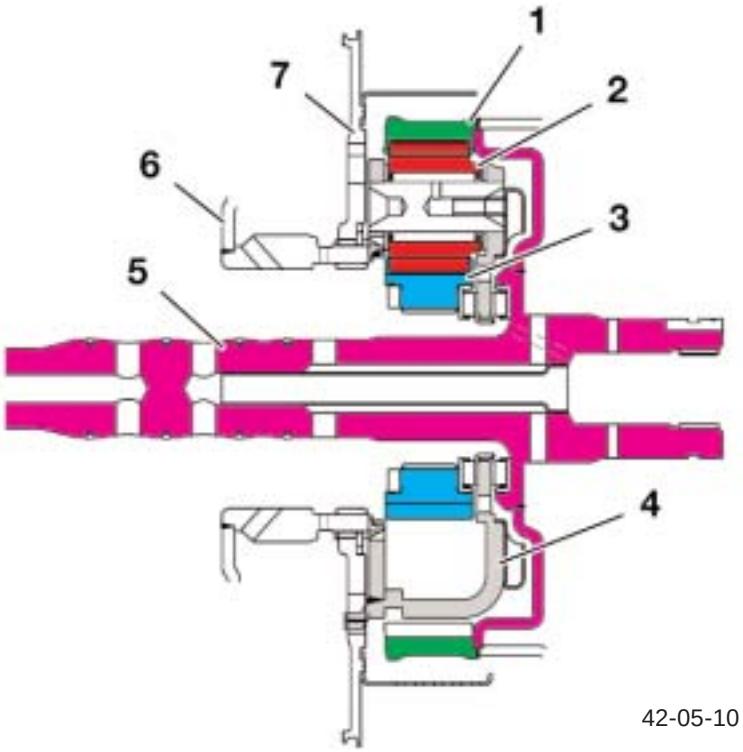
Lepelletier Planetary Gear Train: The Lepelletier planetary gear train provides six forward gears and one reverse gear using a lightweight design. The planetary gear train consists of a single carrier planetary gear train and a downstream double planetary gear train.

The single carrier planetary gear train consists of:



1. Internal gear 1
2. Planet gear
3. Planet carrier
4. Planet carrier
5. Turbine shaft
6. Cylinder A
7. Pressure plate A



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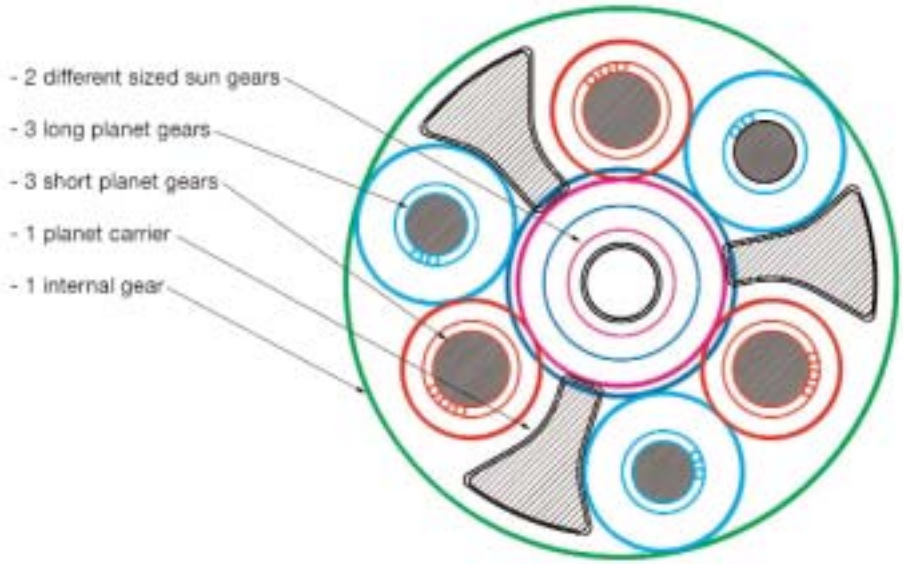
Lepelletier Planetary Gear Train

Double Planetary Gear Train: The series connected double planetary gear train consists of:



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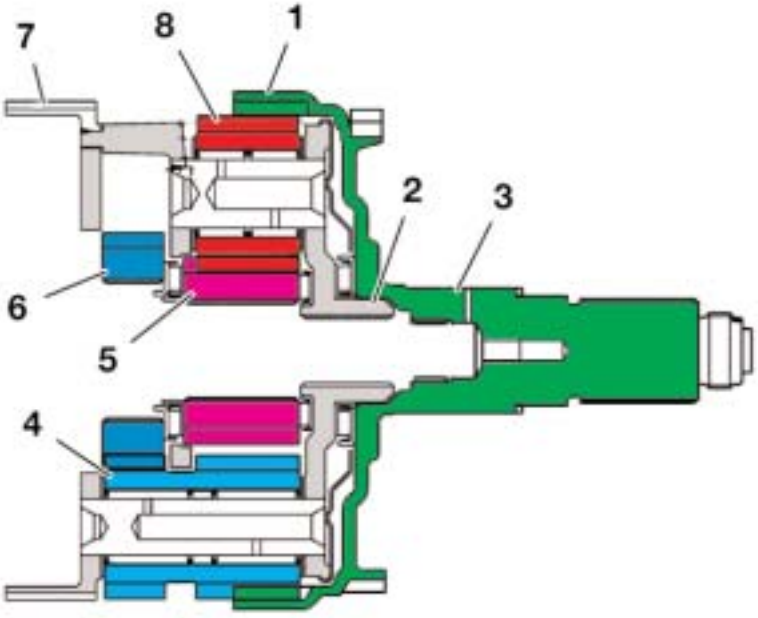


1. Internal gear 2
2. Planet carrier, clutch E
3. Output
4. Double planet gear (long)
5. Sun gear 3, clutch E
6. Sun gear 2, clutch A
7. Planet carrier 1
8. Planet gear (short)

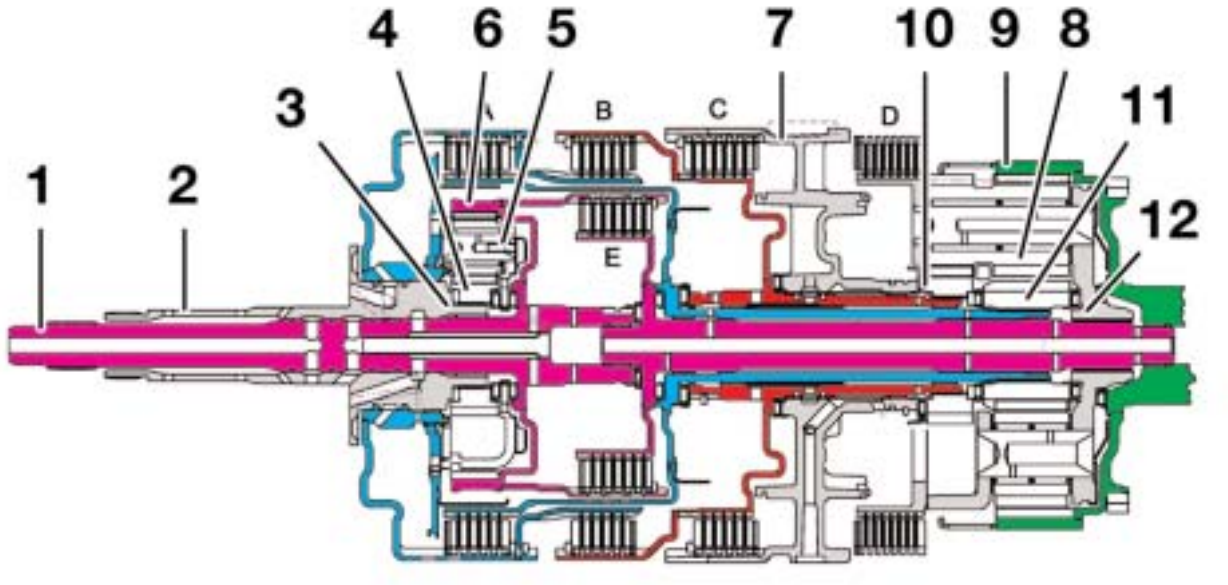
42-05-12

Double Planetary Gear Train

Power Transfer in the Planetary Gear Train

Principle of Operation

Neutral Position: The turbine shaft drives the internal gear for the front single planetary gear train and the outer disc carrier of clutch E. The internal gear drives the planet gears that roll on the fixed sun gear. The planet carrier of the gear train is driven together with the outer disc carrier of clutch A and the inner disc carrier of clutch B. This steps up the drive for clutch A and B.



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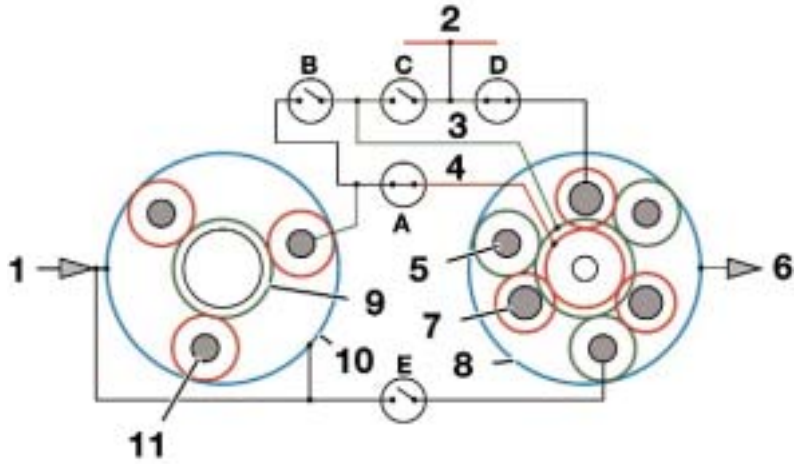
Power Transfer in the Planetary Gear Train

1. Turbine shaft
2. Stator shaft
3. Single gear train
4. Sun gear
5. Planet carrier
6. Internal gear
7. Fixed connection to housing
8. Double gear train
9. Internal gear 2
10. Sun gear 2
11. Sun gear 3
12. Double planet carrier

Power Flow in 1st Gear: Drive clutch A is engaged in 1st gear. The sun gear 3 in the double planetary gear train is driven and is meshed with the short planet gears. Due to clutch D being engaged, the double planet carrier is held by the gearbox housing. As a result, the internal drive gear is driven over the long planet gears (large gear reduction) in the direction of engine rotation.



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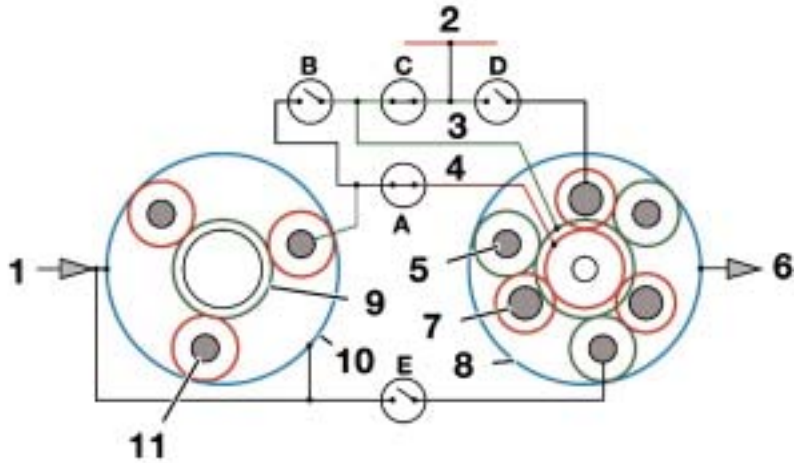
Planetary Gear Train

1. Drive (turbine shaft)
2. Gearbox housing
3. Sun gear 2
4. Sun gear 3
5. Planet gear, long
6. Output
7. Planet gear, short
8. Internal gear 2
9. Sun gear 1 (stator shaft)
10. Internal gear 1
11. Planet carrier

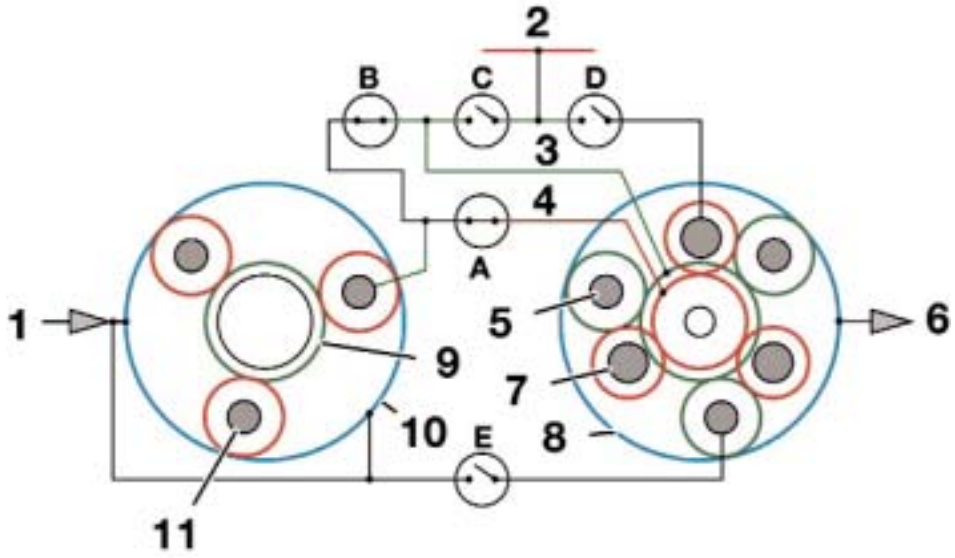
A - Drive clutch
B - Drive clutch
C - Brake clutch
D - Brake clutch
E - Drive clutch

Power Flow in 2nd Gear: Clutch A is also engaged in 2nd gear so that sun gear 3 (4) in the rear gear train is driven. Sun gear 2 (3) in the rear gear train is now blocked by clutch C. The long planet gears and the short planet gears move on rolling contact (reaction) with the fixed sun gear 2 and drive the double planet carrier as well as the internal gear 2 in the direction of engine rotation (gear up - ratio change).



42-05-14

Power Flow in 3rd Gear: As in 1st and 2nd gear, drive clutch A is engaged. Drive clutch B is now also engaged. Both sun gears in the double planetary gear train are driven (reaction). As a result, the gear train moves as an assembly and the gear ratio is achieved only by the front single planetary gear train (gear up - ratio change).



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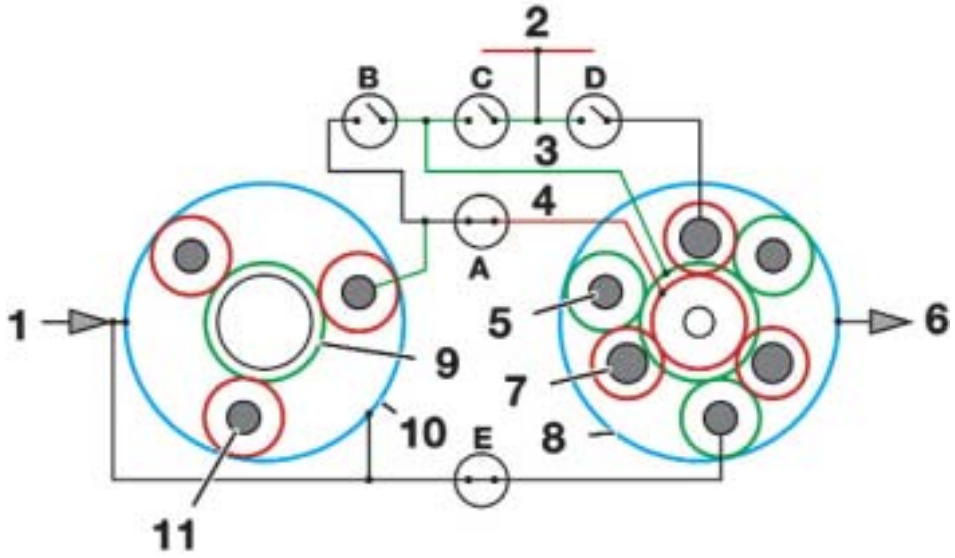
Power Flow in 4th Gear: Drive clutches A and E are engaged in 4th gear. Clutch A drives the sun gear 3 (4). Clutch E drives the planet carrier in the double planetary gear train. Together with the double planet carrier, the long planet gears and the short planet gears drive the internal gear 2 in the direction of engine rotation (gear up - ratio change).



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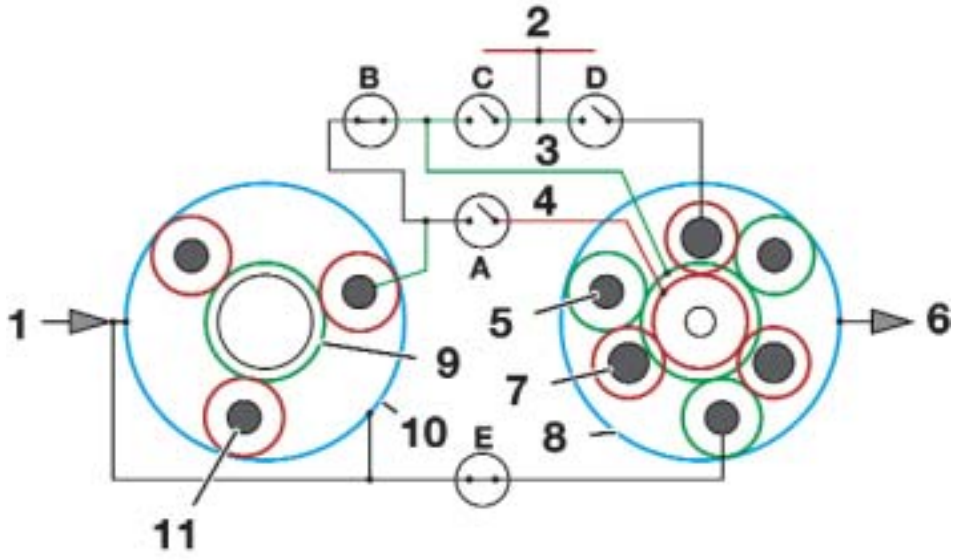
Power Flow in 5th Gear: Drive clutches B and E are engaged in 5th gear. The sun gear 2 (3) in the double planetary gear train is driven by clutch B and the planet carrier of the double planetary gear train by clutch E. Together with the double planet carrier, the long planet gears and the short planet gears drive the internal gear 2 in the direction of engine rotation. ***This results in a gear ratio with a slight overdrive.***



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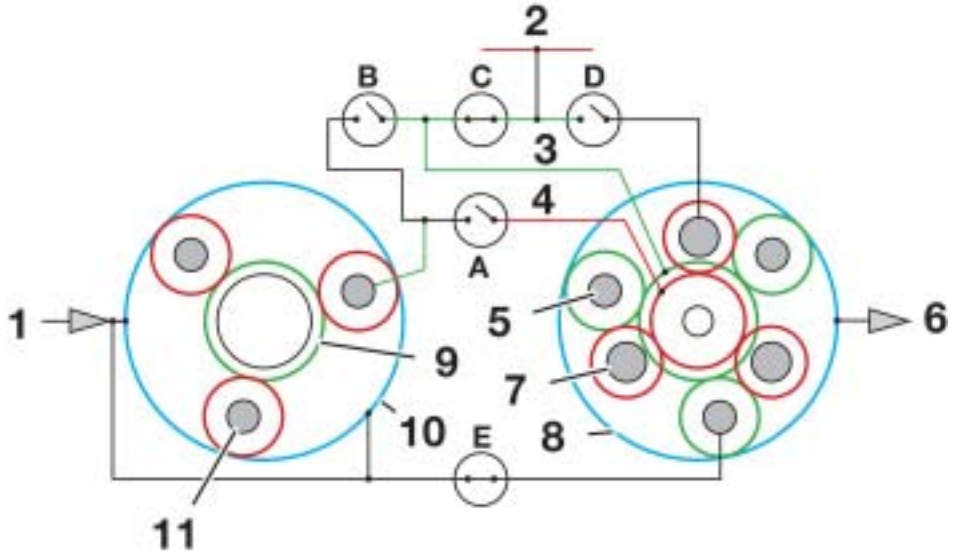
Power Flow in 6th Gear: In 6th gear, the sun gear 2 in the double planetary gear train is blocked by clutch C. The planet carrier is driven by the engaged clutch E. As a result, the long planet gears are forced to move by rolling contact (reaction) on the fixed sun gear 2 (3) and drive the internal gear in the direction of engine rotation. ***This results in a large gear ratio in overdrive.*** The single gear train is not operative in 6th gear.



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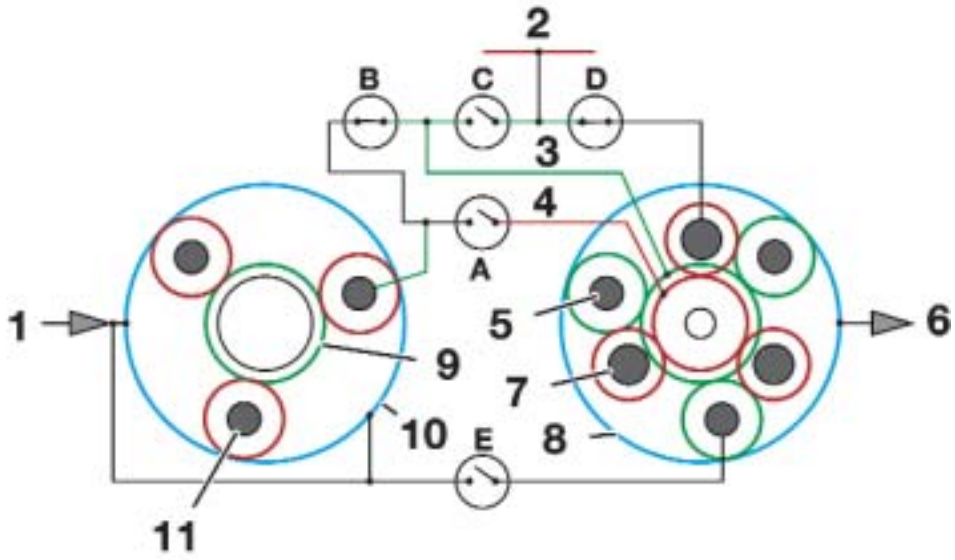
Power Flow in Reverse Gear: The drive clutch B is closed in reverse gear. As a result, the sun gear 2 (3) in the double planetary gear train is driven while being in mesh with the long planet gears. The double planet carrier is supported by brake clutch D and the gear-box housing. The internal gear 2 (output shaft) can now be driven by the long planet gears in the ***opposite direction*** of engine rotation (large gear reduction).



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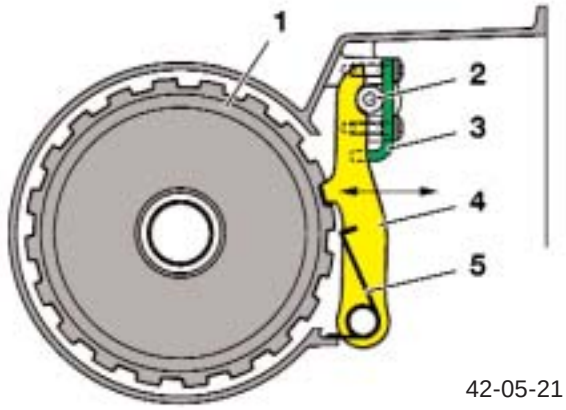
Notes:

Parking Lock

The parking lock secures the vehicle to prevent it from rolling away. When the vehicle is stationary it is electrically applied by a solenoid valve as requested from the selector lever.

The parking lock “locks” the output shaft of the gearbox when the linking rod (2) is extended to pivot the pawl (4) to engage in the gear teeth of the parking lock disc gear wheel (1). The parking lock will hold the vehicle on uphill or downhill gradients of up to 32% and will only engage at speeds below 2 km/h. The Mechatronic Control Module will prevent the parking lock from engaging at speeds above 2 km/h.

1. Parking lock disk (gear wheel)
2. Linking rod
3. Guide plate
4. Parking lock pawl
5. Lock pawl lifting spring



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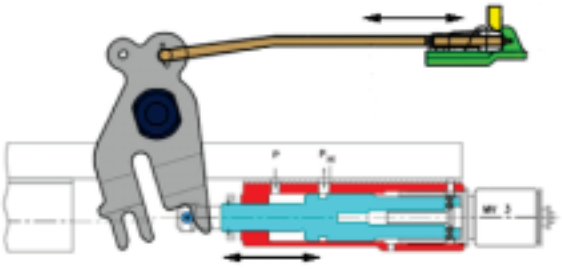
Parking Lock

Principle of Operation

In the electrical parking lock, a combination of mechanical lock engagement (as described above) and electric/hydraulic activation are used. The electrical components include magnetic solenoid valves (MV2 and MV3) mounted on the valve body. MV3 is mounted into the parking lock hydraulic cylinder.

Electrical activation of the parking lock is triggered by a push-button on the selector lever or by removing the ignition key. Activation of the solenoid valves is controlled by the Mechatronic Control Module.



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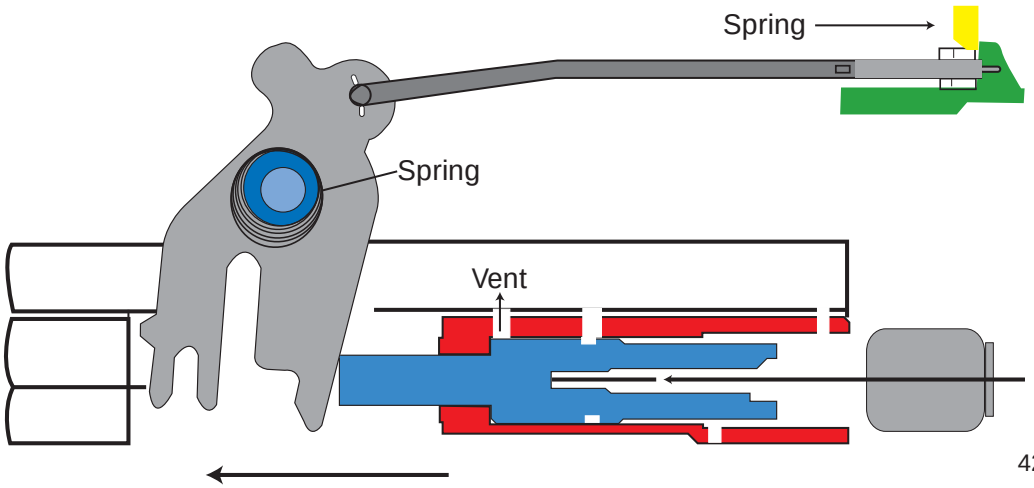
When the parking lock is engaged the solenoid valve (MV3) for the parking lock cylinder is deactivated, cancelling the electro-mechanical lock and the piston released. The solenoid valve (MV2) is also deactivated and the chamber of the parking lock cylinder is vented. The piston is pulled to the parking lock position by a preloaded barrel spring behind the operating lever. The linking rod is extended to pivot the pawl to engage in the parking lock disc.



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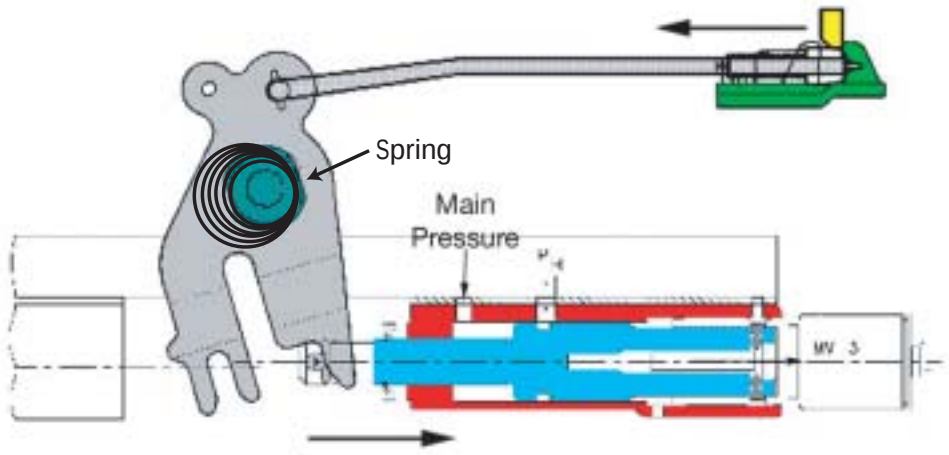
When the parking lock is disengaged (below) the MV2 solenoid valve is activated and the main pressure is applied in the chamber of the parking lock cylinder. This pushes the piston, operating lever and linking rod back to release the parking lock. The parking lock pawl is lifted by a spring to disengage from the gear teeth of the parking lock disc gear wheel. The MV3 solenoid valve for the parking lock cylinder is also activated. The piston is additionally held by locking (detent) balls in position “N” when the engine is not running.

The transmission can be shifted from the park position to position “N” only with the engine running (main pressure required). If engine operation is not possible, the parking lock can be released manually by an additional bowden cable.



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Examples:

- The parking lock is engaged by pressing the “P” push button on the selector lever when the speed signal is less than 2 km/h.
- The parking lock is automatically engaged when the ignition key is removed and the speed signal is 0.
- Position “N” is automatically engaged when the engine is turned off (ignition switched off) with the key remaining in the lock. The park position will be automatically engaged after approximately 30 minutes. Position “N” can remain engaged for a further 30 minutes if position N is selected again before the 30 minutes have elapsed.
- The parking lock is disengaged only by moving the selector lever in position R, D or N with the engine running and the brake pedal pressed.

Interaction Between Parking Lock and EMF: An electromechanical parking brake (EMF), is fitted in the E65. Based on the operating status of the EMF, it is possible to engage the parking lock when the engine is not running in the event of a fault in the EMF.

Interaction During EMF “AUTO HOLD” Function: The parking brake and parking lock is engaged when the driver leaves the vehicle with the engine running with position D or R engaged, seat is not occupied and the door is opened.

Interaction Between EMF and EGS in the Case of Fault: If the EMF cannot switch from the "hold" to "lock" mode, the parking lock is engaged following a plausibility check in the EGS control unit. The plausibility check determines whether position N is engaged, the speed is 0 km/h and the engine and ignition are off.

Notes:

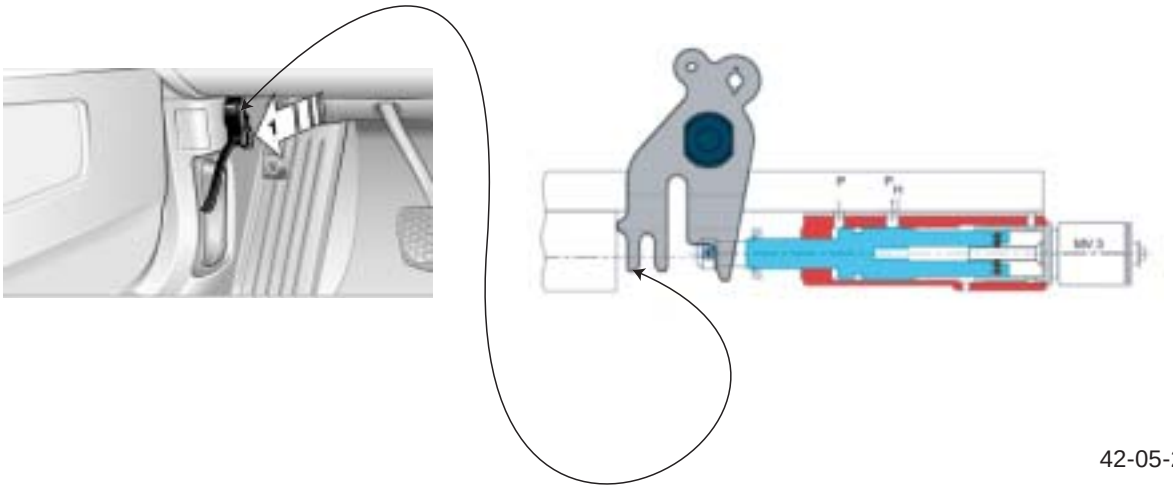
Emergency Release for Parking Lock

A mechanical emergency release is provided if the parking lock can not be automatically released (battery failure, engine, engine electrical system, transmission electrical system, etc.). This allows the vehicle to be towed or pushed as required.

To tow the vehicle, the emergency release must be operated even if the transmission control is fully operable. Depending on the type of fault, the N-hold function cannot be guaranteed during the entire time even if an output speed is recognized (corresponding information in the Owner's Handbook and Towing Instructions for BMW 7 Series).

The emergency release for the parking lock is located in the vehicle interior at the A-pillar in the footwell on the driver's side (1). On US vehicles, the emergency release can only be accessed with the vehicle key releasing the locked cover. ***Before performing this procedure, apply the brake pedal!***

A cable assembly is routed from the operating lever to the gearbox lever on the selector shaft. The emergency release should not be operated during normal vehicle operation. After being released, the "gearbox emergency released" message is displayed in the position indicator section of the instrument cluster.



42-05-25

The emergency release must be reset to re-engage the parking lock after eliminating the fault. The gearbox lever moves during normal operation and must not be influenced by the cable assembly. Press on the red tab on the back side of the lever and guide the lever assembly back into the orignal position.

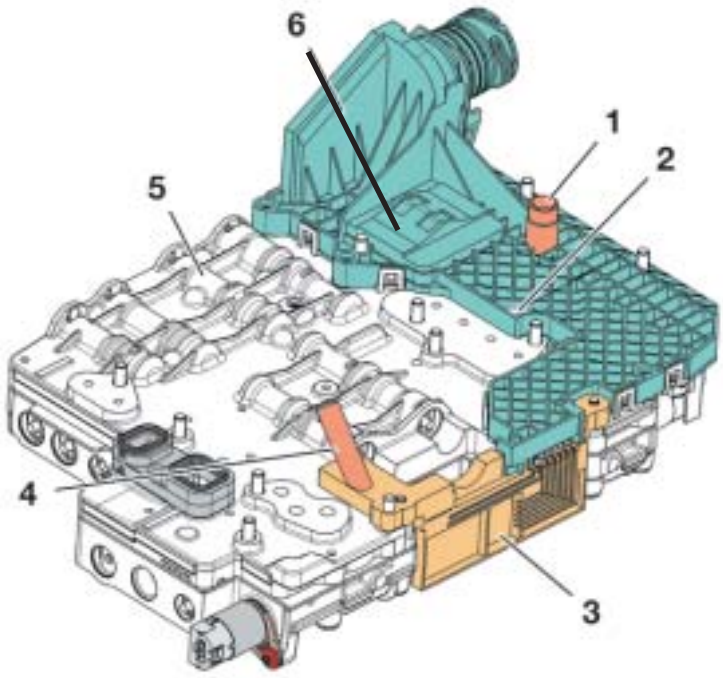
When the emergency release has been operated by mistake or not reset after repairs it is detected by a plausibility check of the actual position by the two park position sensors in the gearbox. In this case, the parking lock cannot be engaged automatically. The driver is informed by an error message in the instrument cluster (Check Control).

Electric-hydraulic Control

System Components

Mechatronic Module: The mechatronic module is a combination of the hydraulic valve body and electronic control module which are installed in the oil sump. This is the first time the mechatronic module is used in a BMW automatic transmission. This offers the advantages of improved shift quality, increased driving comfort and increased reliability due to the reduced number of electrical connections and interfaces.

The hydraulic valve body contains valves, springs, dampers and electric solenoid valves. ***The electronic control module manages the complete electronic control of the transmission and is an integral part of the valve body (replaceable as a complete unit).*** The electronic control module is completely sealed and oil tight.



42-05-26

Electric-Hydraulic Control

1. Output speed sensor
2. Temperature sensor
3. Position switch
4. Turbine (input) speed sensor
5. Hydraulic module (valve body)
6. Electronic Control Module

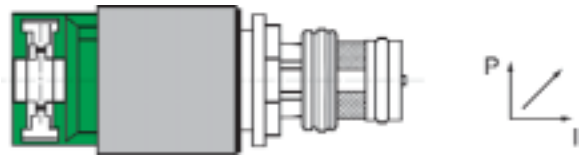
The electronic-hydraulic transmission gearshifts in the GA6HP26Z are controlled by 3 solenoid valves and 6 electronic pressure control valves. These components are not separately replaceable at this time.

Solenoid Valves (MV): Three solenoid valves are mounted on the valve body and are 3/2-way valves, i.e. valves with three hydraulic connections and two electrically switch positions. The solenoid valves are activated by the electronic control module.

Electronic Pressure Control Valves (EDS): The electronic pressure control valves convert electrical current into a proportional hydraulic pressure. They are regulated by the electronic control module to activate the hydraulic valves (in the valve body) to the pistons in the clutch assemblies. Two types of EDS valves are used:

EDS with rising characteristic curve

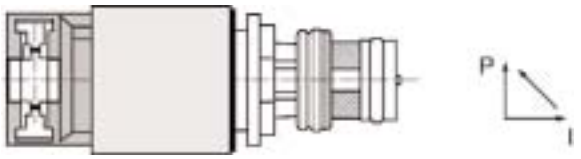
- EDS valves 1, 3 and 6 are identified by a green cap.
- The rising characteristic curve starts at 0 mA = 0 bar, up to 700 mA = 4.6 bar.
- Operating voltage - 12 V
- Resistance at 20 ºC = 5.05 Ohm



42-05-27

EDS with falling characteristic curve

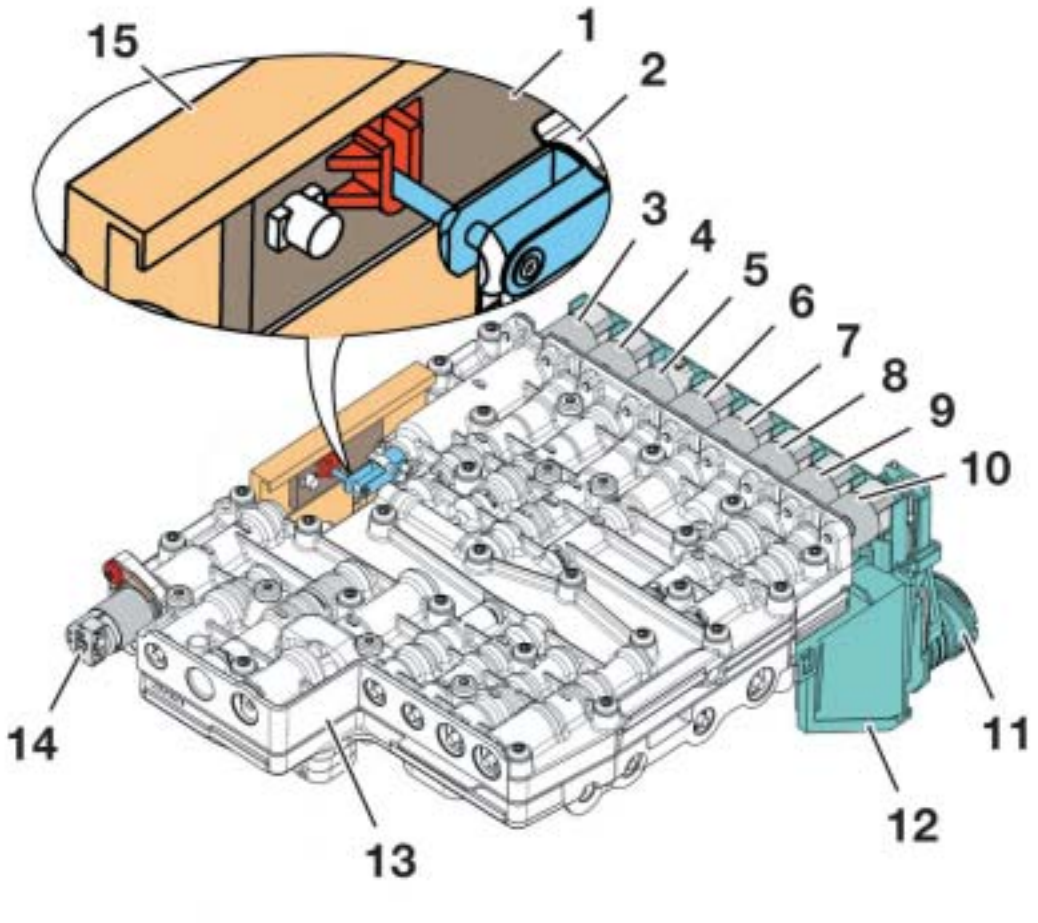
- EDS valves 2, 4 and 5 are identified by a black cap.
- The falling characteristic curve starts at 700 mA = 0 bar, up to 0 mA = 4.6 bar.
- Operating voltage - 12 V
- Resistance at 20 ºC = 5.05 Ohm



42-05-28

Location of Solenoid Valves and Pressure Control Valves

Note: Care must be taken when installing the Mechatronic module to ensure that the piston of the parking lock cylinder (2) is engaged in the position switch (15).



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Solenoid Valves and Pressure Control Valves

1. Position Switch Slide
2. Parking lock cylinder piston
3. Solenoid valve 3, parking lock cylinder
4. EDS
5. Solenoid valve 1
6. EDS 4
7. EDS 5
8. EDS 3
9. EDS 2
10. EDS 1
11. Electronic plug connector
12. Electronic module
13. Hydraulic module (valve body)
14. Solenoid valve 2
15. Position switch

Solenoid Valve and Clutch Logic

POS / gear	Solenoid valve logic									Clutch logic					
		MV		P-EDS						Drive clutches				Brake clutches	
	1	2	3	1	2	3	4	5	6	A	B	E	WK	C	D
P = Park							X	-X-							●
R = Reverse	X	X	X				X	-X-			●				●
N = Neutral	X	X	X				X	-X-							●
D, 1st gear	X	X	X	X			X	-X-	-X-	●			●		●
D, 2nd gear		X	X	X		X		-X-	-X-	●			●	●	
D, 3rd gear			X	X	X			-X-	-X-	●	●		●		
D, 4th gear	X		X	X			X	-X-	-X-	●		●	●		
D, 5th gear	X		X		X		X	-X-	-X-		●	●	●		
D, 6th gear	X		X			X	X	-X-	-X-			●	●	●	
	Shift valve 1	Parking lock valve	Parking lock cylinder	Clutch A	Clutch B	Brake C	Brake D / clutch E	System pressure (situation-related)	Gear logic control (situation-related)	Planet carrier Single gear train	Sun gear 1 (double gear train)	Carrier Double Gear Train	Situation-related control of converter lockup clutch	Sun gear 1 (double gear train)	Planet carrier (double gear train)

X Activated
-X- Situation-related control
● Engaged

42-06-30

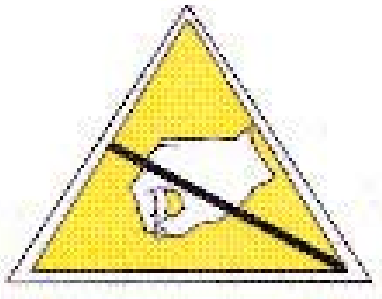
Notes:

Work Shop Hints

Note:

- The transmission requires ***oil replacement every 100,000 miles.***

- Contact the BMW Technical Hotline for additional assistance.



- Consult the Repair Information (in TIS) and the Service Information Bulletins regarding ***static electrical discharge*** before any repair attempts are made to the Mechatronic Module!

- The oil pan can only be removed at temperatures below 40 ºC. The oil pan is made of plastic which will distort at high temperatures.

- External seal replacement, torque converter replacement and replacing the Mechatronic as a unit assembly are the only recommended repairs at this time (aside from replacing the complete transmission). No repair attempts should be made to the valve body components (mechanical or electrical) or the electronic control module.

The drain plug is found in the rear of the oil pan. There are ***final alignment indications*** embossed in the drain plug and the oil pan.

When installing the drain plug, observe the tightening torque. The arrow (embossed in the oil pan) must locate within the range span (embossed in the plug) .

Do not overtighten the drain plug because the plug and oil pan will distort or crack!

42-05-52

The inlet oil filter and debris magnets are integral in the oil pan (replaced as a unit).

When installing the oil pan, observe the tightening torque of the bolts.

Do not overtighten the bolts because the oil pan will distort or crack!

42-05-54

The harness plug insulating sleeve must be removed prior to removing the Mechatronic Module from the transmission housing.

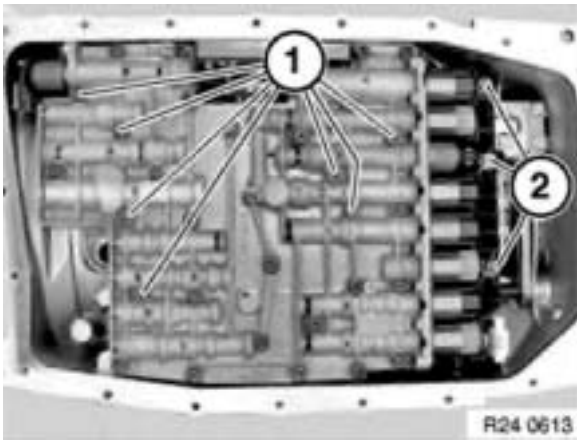
The sleeve is released by sliding the lock lever up as shown to the right. The sleeve is then pulled from the transmission housing.

After the sleeve is installed in the transmission housing, the lock lever must be slid down until it locks.

When unbolting the Mechatronic Module for replacement, ***only the Torx T40 bolts (1) and (2)*** in the diagram are to be loosened to remove the assembly from the transmission housing (as per the Repair Information).

1. = M6 x 58 mm
2. = M6 x 20 mm

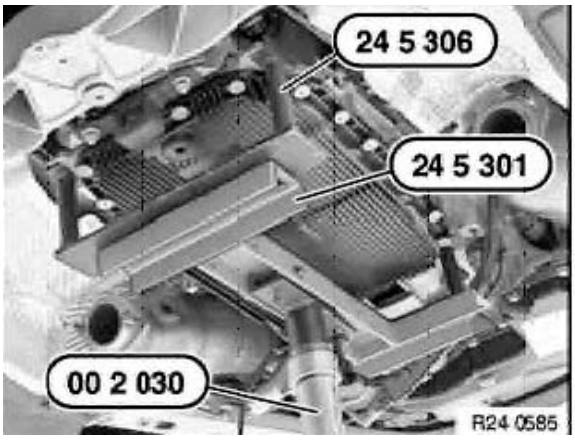
Consult the ***TIS for the correct tightening torque*** on installation. When installing the Mechatronic module, make sure that the piston of the parking lock cylinder and the control lever is engaged in the position switch.



42-05-14

Mechatronic Removal

Use the ***Transmission Support (Special Tool) PN 90 88 6 245 306*** in conjunction with 88 88 6 002 030 for removal/installation of the complete transmission.

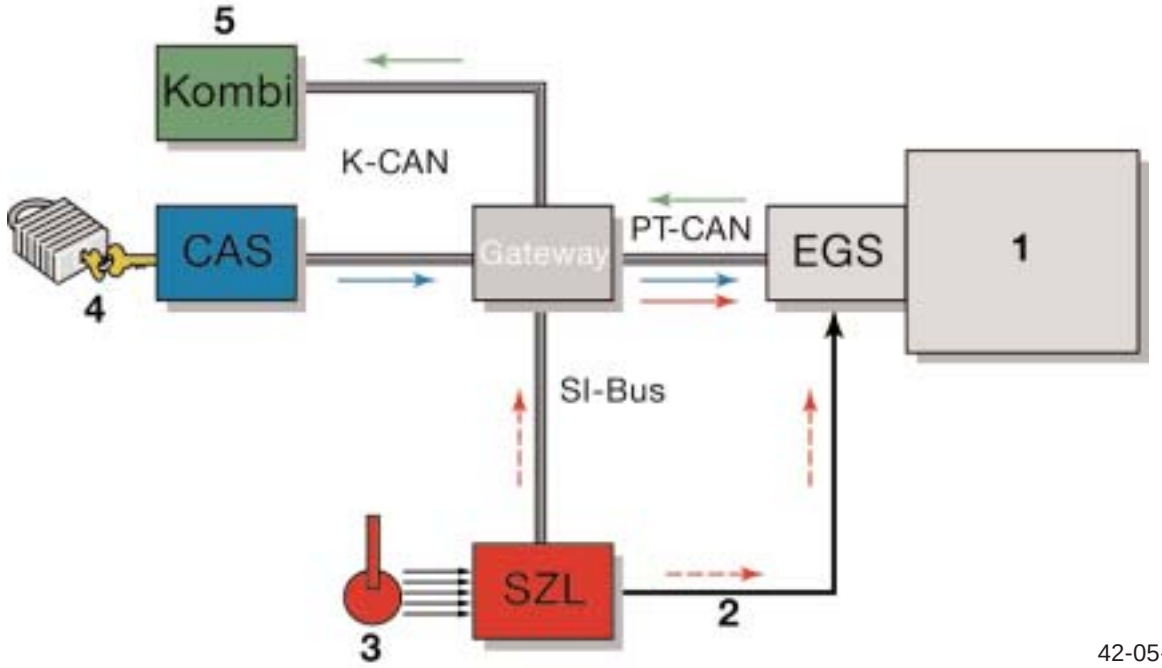


42-05-13

Transmission Removal

Electronic Transmission Control

The electronic transmission control module is an integral part of the Mechatronic Module. The electronic inputs are evaluated in the control module and electronic actuation is output to control the shifts and regulate shift quality. The control module is integrated in the E65 electrical system by the PT-CAN bus (power train) connection and a separate data link (hardwire) for signal transfer between components.



42-05-32

Electronic Transmission Control

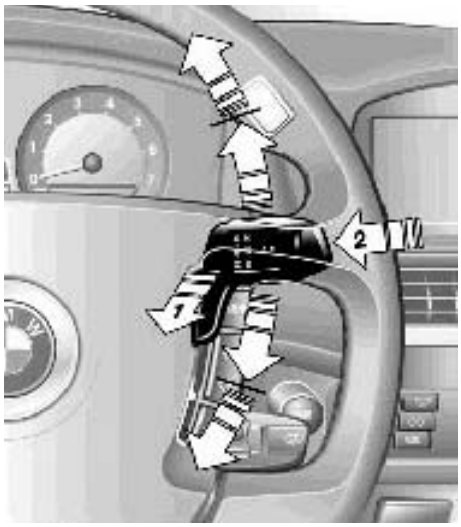
1. Automatic transmission
2. Serial, unidirectional line (hardwire)
3. Selector lever
4. Ignition Key
5. Display, position indicator

CAS module-Car access system
Gateway-Central gateway module (ZGM)
EGS-Electronic transmission control module
SZL-Steering column switch center
PT-CAN (Powertrain)
K-CAN (Body)
SI-Bus-Safety and Information Bus, byteflight optical fiber

In addition to the bus line, the signal transfer between the steering column switch center (SZL) and the transmission control module additionally takes place over a unidirectional serial line (hardwire) for safety reasons. The central gateway module (ZGM) is a link in the data transfer from one bus to another.

The data required for gear shifts are injection timing, engine speed, Valvetronic position, engine temperature and engine intervention. These signals are transmitted between the ECM and transmission control module over the PT-CAN bus.

System Components



42-05-14

Selector Lever: The selector lever is located on upper right of the steering column. Shift position N, D and R are possible. The parking lock P is operated with a push button on the end of the selector lever (2).

All gearshifts are electrically controlled - ***there is no mechanical connection to the gearbox from this lever.*** The positions are indicated in the instrument cluster.

Selector Lever Positions in Automatic Mode

The shift pattern consists of positions R, N, D and the corresponding arrows. The selector lever can be moved from its mid-position by pulling back towards the driver (1). The lever can then be moved in a clockwise or counterclockwise direction and returns from each position automatically to the mid-position. Position P is separated from the shift pattern and is activated by pressing the push button at the end of the selector lever (2).

- **Position R:** With the brake pedal pressed, the selector lever must be pulled back and pressed as far as it will go in the counterclockwise direction (past detent).

- **Position N:** With position R engaged, N can be engaged by pulling the selector lever back and pressing it in the clockwise direction (up to but not beyond detent). When position D is engaged, position N can be engaged by pulling the selector lever back and pressing it in the counterclockise direction (up to but not beyond detent). When position P is engaged, position N can be engaged by pulling the selector lever back and pressing it in either direction.

- **Position D:** With the brake pedal pressed, the selector lever must be pulled back and pressed as far as it will go in the clockwise direction (past detent).

- **Position P:** Position P is engaged by pressing the push button integrated in the selector lever. The parking lock is released by depressing the brake pedal and engaging position R, N or D.

Special Features

- The transmission can be shifted from the park position to position “N” only with the engine running (main pressure required) and the brake pedal depressed.

Automated Functions

- The park position is automatically engaged when the ignition key is removed.

- Position N is engaged automatically when the engine is turned off and the ignition is switched off with the key remaining in the lock. The park position is then automatically engaged after approximately 30 minutes. Position N can remain engaged for an additional 30 minutes if position N is selected again before the 30 minutes have elapsed.

L/D Push Button in MFL: US vehicles are equipped with the L mode (limiting function) which allows the driver to suppress certain shifts (ascending or descending steep grades).

Starting from position D, the limitation mode is selected by pressing the L/D push button. Initially, the current gear is retained and the vehicle will not upshift to a higher gear.

The system returns to the automatic mode by pressing the L/D button again or pressing the selector lever to position D.

Example: Position D is engaged and the gearbox is in 4th gear. After pressing the L/D push button in the MFL, 4th gear is retained and is the upper limit. Gears 1 through 4 will be shifted automatically when the vehicle is driven.

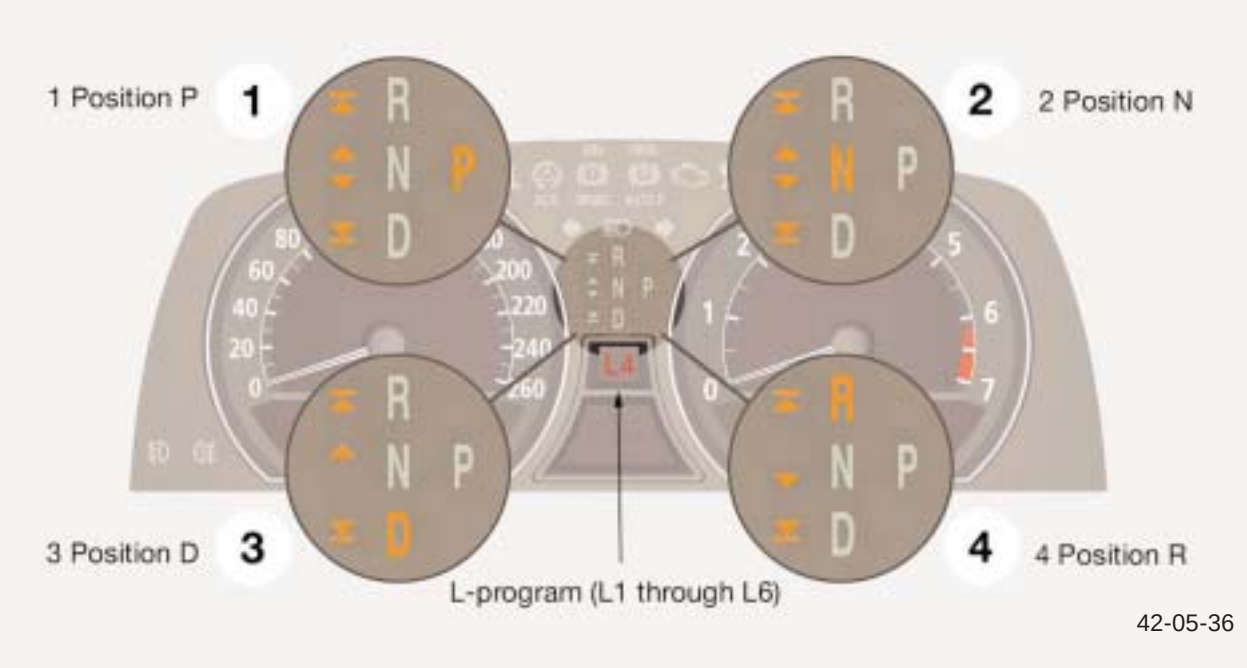
42-05-15

There are two push buttons integrated in the steering wheel facing the driver (ten and two o'clock position as shown above). The limitation stages are manually downshifted by pressing either of these buttons when the L mode is selected. It is not possible to upshift the limitation stages. There is no forced upshift when reaching the maximum engine speed.

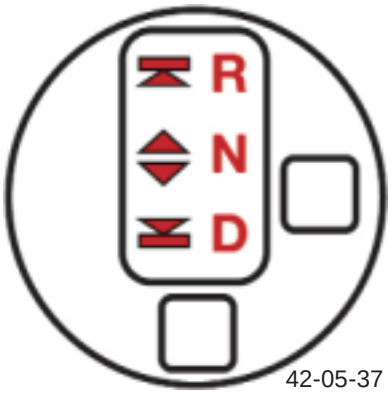
When the L mode is selected, the indicator in the instrument cluster will illuminate to indicate L1 through L6.

Impermissible shift requests, such as a down shift that will cause the engine to exceed the maximum speed are suppressed by the transmission control module and are indicated only temporarily in the instrument cluster.

Position Indication with Shift Pattern: The engaged position is only indicated in the instrument cluster. Depending on what position is selected, the corresponding selection is illuminated in the shift pattern. The arrows indicating the possible movement directions of the selector lever are also illuminated. An additional indication is provided in the L mode.



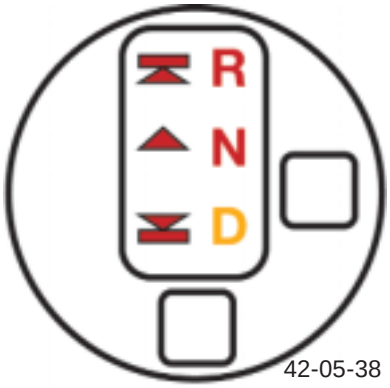
After switching on the ignition and starting the engine, the P or N positions and all of the arrows are indicated. In positions D or R, the single arrow for the shift direction to return to N is indicated (next to the N indicator).



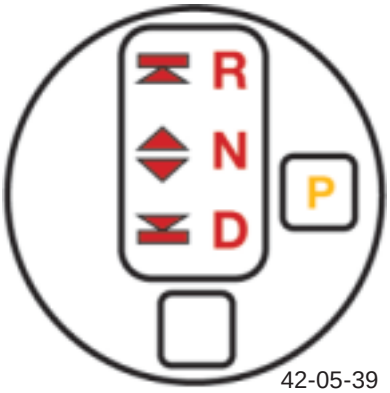
Detailed explanations for Typical Indications:

The ***shift pattern*** consists of the locator illumination for the R, N and D positions with the associated arrows. This is indicated when the ignition is "ON" and the transmission is not in position P.

The ***position indicator*** for R, N or D is highlighted corresponding to the engaged gear position (position D is highlighted here). The positions are indicated when the ignition is "ON" and the transmission is not in position P.

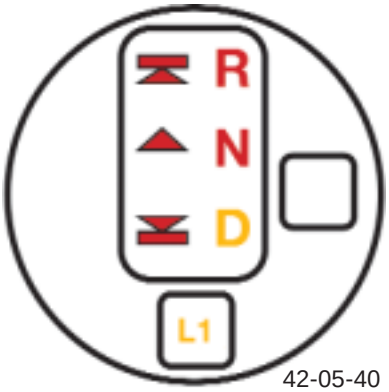


Position P is separate from the actual shift pattern. P is indicated in the instrument cluster only when the park position is engaged and the ignition is “ON”.



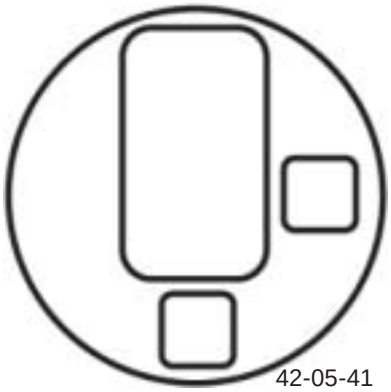
42-05-39

The ***L mode*** is indicated in a separate display and illuminates L1 through L6 when the L mode is selected. Impermissible shift requests, such as a down shift that will cause the engine to exceed the maximum speed are suppressed by the transmission control module and are indicated only temporarily.

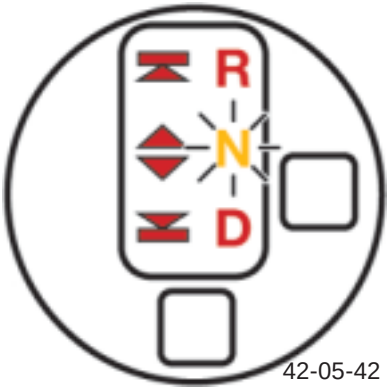


42-05-40

The indicator in the instrument cluster is ***blank*** when the P position is engaged and the bus is in sleep mode. This can also occur when position P is engaged and the bus wakes up, the CAN signals are valid but terminal 15 is OFF.


42-05-41

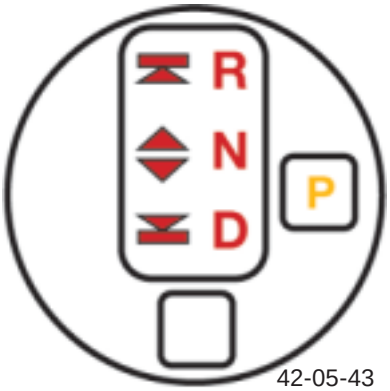
The N position indicator will begin to ***flash*** before the N-hold function elapses (30 min). Flashing takes place at a frequency of 1.5 Hz, controlled by the transmission control module.



42-05-42

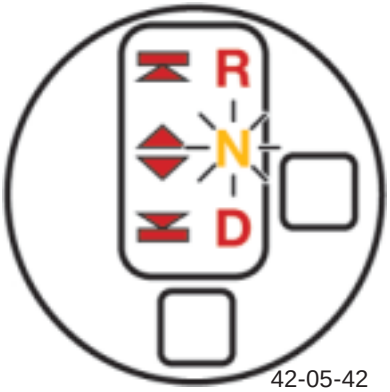
Detailed explanations for Fault Indications:

When the ***CAN signals are invalid*** and the activation line is "high", the shift pattern and P position indicator are illuminated when position P is engaged (Bus is awake).



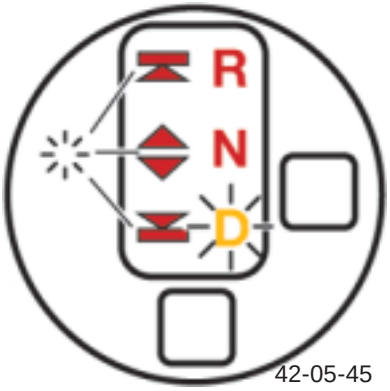
42-05-43

When the ignition is switched “ON” and the transmission control module ***does not detect the P position***, position N will flash in addition to the Check Control message “emergency release may be operated”. This can also occur if the Bus is awake, KL15 is ON and the Bus activation line is "high".



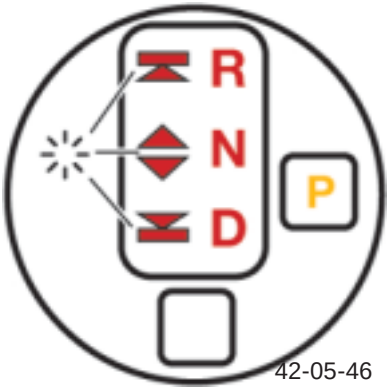
42-05-42

This display is illuminated when the transmission is in the ***mechanical emergency operation*** (with forward movement). The R and N illumination will remain on and all of the arrows along with the D position indicator will flash at a frequency 1.5 Hz.



42-05-45

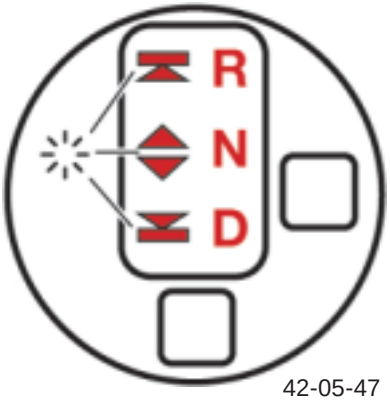
This display is illuminated when the transmission is in the ***mechanical emergency operation*** and in the P position. All of the arrows will flash at a frequency 1.5 Hz. The shift pattern locator illumination for R, N, D will remain on and the P position is indicated.



42-05-46

This display is illuminated when the transmission is in the ***mechanical or electrical emergency operation and the CAN communication is not functional.***

In the event of a transmission failure or a CAN bus error, the instrument cluster assumes control and will illuminate this display. All of the arrows will flash at a frequency 1.5 Hz. The shift pattern locator illumination for R, N and D will remain on and the P position indicator is switched off.



42-05-47

Notes:

Principle of Operation

The data required for gear shifts is transmitted between the ECM and transmission control module (EGS). The transmission control module requires additional information from the vehicle for operation. In addition, other control modules in the E65 require information about the electronic transmission status.

The PT-CAN bus is used for this purpose, below is a list of the the signals and components:

Signals	Transmitter	Receiver
Selector switch	SZL	EGS
Ignition terminal status	CAS	EGS
Central locking system	CAS	EGS
Transmission data (P/N)	EGS	CAS
Engine data	ECM	EGS
Wheel speeds	DSC	EGS
Deceleration request	EMF	EGS
Display, transmission data	EGS	Instrument cluster
Check Control message	EGS	Instrument cluster
Torque requirement	EGS	ECM
Battery voltage	Power module	EGS
Electric loads (30 min. N hold)	EGS	Power module

Note: The turbine (input) and output speeds of the gearbox are determined with Hall sensors that transfer the values directly to the electronic transmission control module. The position switch also transfers information directly over a hardwire.

As in previous transmission control modules, the “flash” programmable coding is for the new control module.

The processor of the transmission control module features a 440 KB internal flash memory. Approximately 370 KB of this is taken up by the basic transmission program. The remaining 70 KB contain the vehicle specific application data.

Interlock

The CAS module signals the "ignition key inserted or not inserted" status to the transmission control module. The parking lock is engaged in the transmission when "ignition key not inserted" is signalled. The parking lock can only be released when the ignition key is inserted, the engine is running, the brake pedal is depressed (Shiftlock) and R, N, or D is selected.

Starter Interlock

The engine will only start in position P or N. The CAS module evaluates two signals from the transmission control module to activate the starter:

- The gearbox P or N position (CAN signal)
- Position P over the hardware line from the P position sensors

The engine can still be started in position P in the event of a CAN signal fault. The engine can not be started if the emergency release is operated (not in P position). In addition to evaluating these two signals when the ignition is switched “OFF”, the transmission always rests in "hydraulic neutral" so the gearbox will not transfer power during an engine start.

Warm-up Program

The warm-up program is selected after every engine start when the engine temperature is below 60 ºC (approx.). The upshifts occur at a higher engine rpm allowing the engine and catalytic converters to reach operating temperature faster. The warm-up program is not in effect when the engine temperature is above 60 ºC or after 120 seconds of operation.

Downshift Inhibit

This function prevents a downshift when the maximum engine speed will be exceeded, preventing engine and transmission damage.

Reverse Interlock

This prevents shifting into reverse gear at a speed above 5 km/h. If the reverse gear is selected at a speed above 5 km/h, the gearbox will shift into neutral and N is indicated in the instrument cluster. Only when the vehicle has reached a speed of less than 5 km/h is it possible to select reverse gear by operating the selector lever again.

Adaptive Transmission Control

As in the previous automatic transmissions, there are different adaptation modes for the A-program (automatic - in selector lever position D) in the 6-speed automatic transmission.

Adaptive transmission control provides the following features:

- Shift points and shift pressures based on driver type
- Maintains shift quality over the lifetime of the transmission through adaptive pressure control
- Torque converter lock up clutch.

In the A-program, only the basic shift characteristic map XE (extreme economy) and the performance-oriented shift characteristic map E (economy) are selected. The A-program offers the driver comfortable gearshift characteristics with very smooth gear changes.

The control module simultaneously monitors engine speed, turbine (input) speed and output speed. This is necessary to determine the slip ratio and slip time during a shift. Slip ratio and slip time are influenced by production differences between transmissions and normal wear.

The control module performs the adaptive pressure control function by modifying the control of the EDS valves increasing the clutch apply pressures to compensate for internal slip. The adaptive pressure control function optimizes the shift quality and increases the life span of the clutch plates.

Pressure adaptation takes place automatically while driving. After performing repairs on the transmission, it is necessary to reset the pressure adaptation with the DISplus. A test drive should then be performed ensuring that the transmission is driven in all gears.

Driver Type Adaptation

In the 6-speed automatic transmission, the driver type adaptation is based on the values of kick-fast, cornering evaluation, brake evaluation and constant driving evaluation. The adaptation function evaluates the longitudinal and transverse dynamics from the standard controls such as accelerator pedal, brake and steering. The current driving status and driver's load choice are calculated from these values.

Based on these values, the adaptation offers a basic gearshift program. To achieve the most fuel economy and comfort, a conservative shift characteristic is selected for driving situations without specific power requirements.

For example, when driving in the highest possible gear and increased power is required, a downshift is not implemented before the engine outputs the full torque. The downshift thresholds are very low so that a maximum of 2 gears can be downshifted over the full pedal travel range. Since this is not the optimum for each situation, the vehicle operation assessment function automatically provides the most suitable basic gearshift strategy.

Kick-Fast

The kick-fast function can change the basic gearshift program depending on the rate of speed that the accelerator pedal is pressed. The accelerator pedal value is compared to a threshold in the control module. As a result, one of two possible functions is selected:

- XE, extreme economy
- E, economy

Moderate movement results in moderate shifts while a quick application of the throttle initiates performance shifts.

Cornering Evaluation

This feature is activated when the control module detects a variation in front and rear wheel speeds (while cornering) from the DSC control module. In addition, the DSC monitors the steering angle sensor, yaw rate and overall vehicle speed to further determine the cornering forces.

When curves are recognized, the control module prohibits up shifting until the wheel speed signals equalize indicating the vehicle is driving straight ahead. Downshifts in conjunction with high power while negotiating a curve can have a negative influence on the stability of the vehicle.

Brake Evaluation

Using the same evaluation method as kick-fast, brake evaluation provides driver type information. Overrun downshifts are triggered at various high speeds depending on the braking requirement.

The vehicle deceleration is determined by the change in the speed proportional signals (wheel speeds or transmission output speed) or the braking pressure in the brake system. The shift speed for the individual downshifts (determined from one of the characteristic curves), depends on the set drive mode, the initial speed at the start of braking and the determined deceleration or brake pressure.

Constant Driving Evaluation

Constant driving evaluation takes place when the driver maintains a constant accelerator pedal position and the vehicle speed does not change. When requested, a downshift takes place immediately in the A-program.

Winter Program

The winter program is activated for the best possible stability and driving safety on slippery roads in winter in addition to control interventions by DSC. Wheel slip is evaluated by the control module based on wheel speed signal data provided by the DSC system over the PT-CAN bus. The control module modifies shift characteristics to match winter mode for better traction.

When active, the transmission will start in second gear and the shift points are lowered. The purpose of this program is to improve the stability of the vehicle with slippery road conditions. Downshift requests that would cause wheel spin are suppressed.

Hill Recognition Function

The control module activates this feature when it detects a high engine load (constant driving resistance) condition at lower road speeds. When the vehicle is traveling up hill the shift points are raised to prevent repetitive up/down shifting.

The parameters that reside in the control module for this feature include vehicle weight, gearbox, differential ratio, rolling resistance and wind resistance.

To adapt for performance reduction of the engine at high altitude, the uphill adaptation is influenced by the altitude compensation function in the ECM.

Cruise Control Shift Strategy

The cruise control function supports speed controlled operation to achieve smooth overall driving characteristics. This function ensures that the acceleration requested of cruise control is achieved while ensuring comfort is not impaired by increased gearshifts.

When cruise control is activated by the ECM, the transmission control module is notified over the PT-CAN bus. The transmission control module activates the program for cruise control operation which minimizes locking/unlocking of the torque converter clutch and up/down shifting. Additionally, the cruise control can request a downshift if the vehicle speed exceeds the set speed limit when coasting downhill.

Notes:

Emergency Programs

The following designs of the GA6HP26Z are used to reduce faults:

- Reduction of system interfaces by using the Mechatronic (assembly)
- Redundant selector lever signals and monitoring (PT-CAN and hardwire)
- Multiple substitute programs

  Substitute program 1: restricted gear selection

  Substitute program 2: corresponds to previous emergency program with only forward, reverse, neutral and park positions possible

  Actuator (MV and EDS) deactivation: hydraulic/mechanical emergency operation

Electrical Emergency Program

The electrical emergency program shifts the transmission into 5th or 3rd gear (speed and previous gear dependent) after a CAN bus failure. After restarting the engine, 3rd gear is engaged when selecting position D. After a CAN bus failure, positions P, R, N and D are selected via a separate serial line (hardwire).

Caution: The Shiftlock function is also deactivated, making it is possible to engage a gear without pressing the brake pedal. This is also indicated by a Check Control message.

When KL15 is switched “OFF”, position P will be engaged immediately at speeds below 2 km/h. This is because the "key inserted/key not inserted" signal is not detected. The N-hold function is not possible with "engine off" (*Caution* in car wash systems).

The instrument cluster can not detect a position change. The position indicator in the instrument cluster is blanked out. The shift pattern with R, N, D remains and the arrows will flash.

Notes:

Mechanical Emergency Program

The following applies in the event of total failure of the transmission control:

- No interruption in power transfer while driving forward (no gear changes)
- When the vehicle is stationary and "engine off": the parking lock will be engaged

The transmission electronics may still be in operation during the mechanical emergency program, communication may also still be possible but the power supply to the actuators (MV and EDS) is deactivated. The hydraulic system of the gearbox is designed so that restricted operation is still possible.

It is not possible to reselect a drive position with the selector lever. This means the vehicle can only be driven forward within certain restrictions until the engine is switched off. ***A drive position can not be engaged after turning the ignition off and restarting the engine.***

Vehicle safety is ensured because the parking lock engages when it is depressurized. As soon as the pressure in the parking lock cylinder drops the parking lock system is pretensioned mechanically (operating lever spring). The mechanical parking lock will not engage at speeds > 5 km/h. ***Once engaged, the parking lock can only be released with the mechanical emergency release.***

When the mechanical emergency program occurs:

- While driving forward, it is still possible to continue driving in 3rd/5th gear (3rd gear when 1st, 2nd or 3rd gear was previously engaged, 5th gear when 4th, 5th or 6th gear was engaged). This is interrupted by turning off the engine, the parking lock will engage once the hydraulic pressure has dropped.
- While in reverse, the gearbox assumes the neutral position and the parking lock is engaged (< 5 km/h).
- While in hydraulic neutral, the parking lock will engage (< 5km/h).
- In position P, the gearbox remains in this status and the parking lock remains engaged.

The driver is informed of the different emergency situations by the Check Control messages.

Feedback in the Event of a Failure

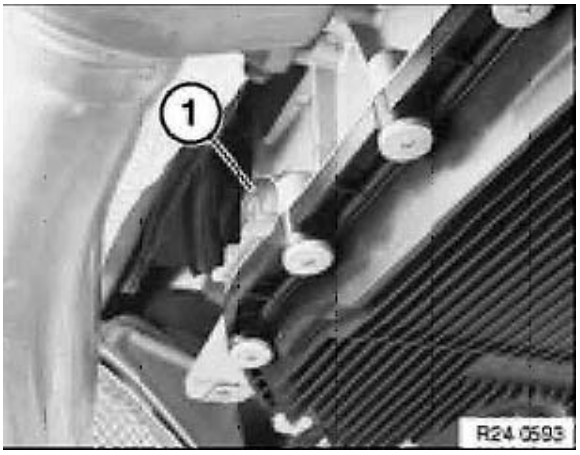
In the event of a total failure of the transmission control or the SZL, the selector lever operation can not be detected or implemented. In addition to the flashing shift pattern and the corresponding error symbols (shown to the right) in the instrument cluster, additional warnings will draw the driver's attention to the situation:

- Acoustic warning signal (gong)

- Acceleration limitation: This function reduces the start-off acceleration when the vehicle begins to move. This function is implemented by the ECM, depending on the restriction of the transmission control by a request or by PT-CAN timeout of the signals.

Workshop Hints

The GA6HP26Z automatic gearbox requires ***oil replacement every 100,000 miles.*** Only the approved oil must be used for replacement or after conducting repairs on the gearbox (consult the Operating Fluids information). Check oil level:



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- The vehicle must be parked flat and level

- Check the oil level through fill plug (1) corresponding to the Repair Instructions (TIS)

- Observe the oil temperature *

* Diagnosis of this gearbox is carried out with the DISplus as part of the service and repair work.

A ***16 Pin Adapter Cable PN 90 88 6 246 080*** is used in conjunction with break out box 88 88 6 611 459 to adapt to transmission harness.

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Check Control Messages

The E65 has different warning and information outputs depending on the driving situation and possible faults. The display provides more detailed information with longer and understandable texts in the control display. The message texts and characteristics are stored in the instrument cluster and are initiated by the transmission control module's evaluation of the fault. Only the transmission relevant faults and special messages are shown in the following charts.

Driving Situation Fault/consequences	Check Control Message	Supplemental Information in the control display
Temperature in gearbox high	Transmission Overheated! Drive moderately	Reverts to default shift program, reduce response. Avoid high speeds and engine loads.
Temperature in gearbox very high	Transmission Stop vehicle carefully	Transmission Overheated. Move selector lever to pos. P. Leave engine running. Allow trans. to cool then carefully cont. driving if problems persist, contact BMW Retail Center.
Selector lever CAN fault	Transmission fault! Drive moderately	Limited transmission operation Danger of complete trans. failure! Please contact the nearest BMW Center.
Key signal, invalid CAS, CAN fault, P-Magnet short to positive or open circuit, parking lock engaged incorrectly.	Trans. Range N only with engine on!	The transmission automatically shifts to P when the engine is switched off. Please contact your BMW Center as soon as possible.
Pos. P mechanical emergency operation active (also applies to emergency operation triggered in Pos. R and N)	Gearbox defective Transmission Fault!	The fault may be resolved by restarting engine. Contact the nearest BMW Center if necessary. Use emergency release to disengage park detent prior to towing or pushing vehicle.
Engine speed invalid ECM CAN fault	Transmission Failsafe! Drive moderately	Only P,R,N,D3 and D5 available Ranges may be engaged without depressing brake. Please contact the nearest BMW Retail Center. Have checked by nearest BMW Retail Center.

Driving Situation Fault/consequences	Check Control Message	Supplemental Information in the control display
Gear, monitoring and shift monitoring	Gearbox position R. Transmission range R. Fault!	Reverse gear cannot be engaged. It maybe impossible to select R. Reduce acceleration. Please contact The nearest BMW center.
Short to ground of an MV, EPS mechanical emergency operation and Pos. D Selector level signal fault (CAN and serial line)	Transmission range P,R, N Fault!	Only transmission range D is available. P engages auto. When engine is switched off Please contact the nearest BMW Retail Center.
V>3km/h, P-push-button invalid. p-sensor implausible	Trans. In P only when stationary!	
Signal from P-push-button invalid. P-sensor implausible	Transmission range P Fault!	Transmission range P may be unavailable. Engage parking brake when vehicle is stationary Please contact the nearest BMW Retail Center.
Parking lock does not engage, possible P-sensor fault, emergency release activated	Gearbox in position N! Transimission in position N!	Gearbox position P is engaged Transmission automatically shifts into P when the remote control unit is extracted from the ignition lock or once 30 minutes have elapsed.
Indicate in N-hold phase with door open or seat occupancy = 0 indication in H-hold phase with selector lever operation D,R, and N Detected	Transmission in position N!	Gearbox position P is engaged. Transmission automatically Shifts into P when the remote control unit is extracted from the ignition lock or 30 minutes have elapsed.
EGS CAN interface defective (gearbox fault probably) instrument cluster cannot receive valid display message from EGS. Passive message from Instrument cluster.	Transmission Fault! Drive Moderately	No transmission display. Poss. Reduction of gear selections. Possible to select new gears without depressing the brake. Please contact the nearest BMW Center.

Driving Situation Fault/consequences	Check Control Message	Supplemental Information in the control display
Indicate at terminal 15 on and door open or seat occupancy =0	Gearbox in position N! Transmission in position N!	Gearbox position P is engaged.
Shift lock note	To engage gear, brake	
Brake signal invalid Brake signal implausible	Gear engage without brake poss!	Before engaging gear, Press brake. When leaving the vehicle, switch off the engine. Accident hazzard! Please contact your BMW Retail Center as soon as possilble.
Indication in the event of sloppy operation or P-push-button faulty	Repeat gear selection	
Messege before N-hold phase elapse (30 minutes)	Transmission position P engaging!	To maintain transmission range N, press selecto lever within 10S to position N.
Gear monitoring Shift monitoring	Transmission Failsafe! Drive moderately	Transmission failsafe program activated. Possilbe reduced acceleration. Please contact the nearest BMW Center.
Ignition on and N engine = 0 and gearbox Pos. P and selector lever push to N	Pos. R, N, D Only within engine on.	

Review Questions

1. What does the GA6HP26Z designation stand for?

   G HP A 26 6 Z

2. Describe Stand By Control:

3. Name the clutches used in the GA6HP26Z:

4. What is unique about 5th and 6th gear (as compared to the others)?

5. What happens to the Parking Lock when engine operation is not possible?

6. What does the Emergency Release do?

7. The Mechatronic includes what components?

8. Name the two paths of communication for the Selector Lever: _____ & _____

9. What is the L/D Push Button for?